

PATENT ABSTRACTS OF JAPAN(11)Publication number : **09-300106**(43)Date of publication of application : **25.11.1997**

(51)Int.Cl.

B23B 27/14**C23C 14/06**(21)Application number : **08-150100**(71)Applicant : **HITACHI TOOL ENG LTD**(22)Date of filing : **21.05.1996**(72)Inventor : **KUBOTA KAZUYUKI
SHIMA NOBUHIKO****(54) THROW-AWAY INSERT OF SURFACE COATED SUPER-HARD ALLOY**

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a tool having an increased close contact in which a further longer life of the tool in respect to a machining of a high hard steel material, i.e., an anti-oxidizing characteristic and an anti-peeling characteristic ranging from an initial period of cutting to a final period can be improved and an anti-wearing characteristic of the original coat itself can be realized.

SOLUTION: A throw-away insert covered with complex nitride or the like of Ti and Al is constituted such that a value of $I_b(220)/I_a(111)$ is within a range of $0 < I_b/I_a \leq 5.0$ when a defraction intensity at a plane (111) in an X-ray defraction is $I_a(111)$ and a defraction intensity at a plane (220) is $I_b(220)$.

LEGAL STATUS

[Date of request for examination] 31.07.1997

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number] 3003986

[Date of registration] 19.11.1999

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the extremely excellent slow [made from surface coating cemented carbide] away insertion of deficit-proof nature and a peeling resistance.

[0002]

[Description of the Prior Art] About making the hard anodic oxidation coatings which made Ti and aluminum the principal component cover on the surface of cemented carbide, many examples which checked the effect have JP,4-53642,B etc. by adding aluminum to the nitride of conventional Ti, a charcoal nitride, and carbide. However, the improvement of the hard anodic oxidation coatings itself that the oxidation resistance of these check examples by adding aluminum to the conventional coat composition improves was made. Therefore, in a slow [made from surface coating cemented carbide] away insertion, the present condition is that the adhesion of a coat is not fully obtained. Especially in recently, it is in the inclination to process the high degree-of-hardness steel materials after heat treatment, and when such steel materials are processed using the slow [made from surface coating cemented carbide] away insertion which made conventional Ti and conventional aluminum the principal component, coat exfoliation arises [oxidation resistance / cutting stress] easily highly with a bird clapper insufficiently again, and sufficient tool life is not acquired.

[0003]

[Problem(s) to be Solved by the Invention] This invention persons acquired the following knowledge, as a result of repeating research wholeheartedly that the oxidation resistance in a slow [made from surface coating cemented carbide] away insertion and a peeling resistance should be improved. In the latest high degree-of-hardness steel materials, when cutting is carried out using a slow away insertion, a part for an insertion point is exposed to the elevated temperature of 700 degrees C - 800 degrees C. When conventional Ti and conventional aluminum are covered to the slow [made from cemented carbide] away insertion made into the principal component, the frictional resistance of steel and a coat is large, and a part for the insertion point under cutting is further exposed to an elevated temperature, and amounts even to 850 degrees C - 900 degrees C. therefore, such a slow [made from surface coating cemented carbide] away insertion -- setting -- the own oxidation-resistant limitation of a coat -- exceeding -- for example, TiO₂ etc. -- ** -- it said -- a porous oxide film is formed very much Moreover, in the case of such a cutting temperature, it will not escape only in oxidization of a coat but oxidization will attain to even a cemented carbide base. Consequently, it will become brittle, and a coat and a base produce a deficit and exfoliation and serve as an inadequate tool life. Moreover, during cutting, since it is very high, a coat exfoliates, and the cutting stress given to a surface coating slow away insertion serves as a too inadequate tool life. As mentioned above, a peeling resistance is improved over a telophase to processing of such high degree-of-hardness steel materials from a still longer tool life, i.e., oxidation resistance, and the early stages of cutting, and it considers as a raising-adhesion which can demonstrate abrasion resistance of film original technical problem.

[0004]

[Means for Solving the Problem] In the slow away insertion which covered the compound nitride of Ti and aluminum, a charcoal nitride, and carbide as a result of this invention persons' inquiring further wholeheartedly from such a viewpoint The diffraction intensity of the field in the X diffraction (111) of the coat Ia (111), When diffraction intensity of a field is set to Ib (220), the value of Ib (220)/Ia (111) considers as the range of $1.0 < Ib/Ia \leq 5.0$. (220) the time of furthermore (200) setting diffraction intensity of a field to Ic (200) -- the value of Ic (200)/Ia (111) -- $2.0 \leq Ic/Ia \leq 40.0$ -- and It is the insertion which considered as the range of $Ib/Ia < Ic/Ia$ and transposed a part of aluminum to one sort or two sorts or more in Zr, Hf, Y, and Si in the range below 30.0 atom % more than 0.03 atom % to aluminum.

[0005]

[Function] In the X diffraction of a coat, the diffraction intensity I of (111) of a coat, (200), and a field (220) is with $I(111) < I(220) \leq I(200)$ and a bird clapper, and this invention persons found out that the oxidation resistance of a coat and the adhesion of a coat and a cemented carbide base could improve sharply. Usually, the coat which shows orientation strong against a field among the hard anodic oxidation coatings (111) which make conventional Ti and conventional aluminum a principal component takes the structure of a very detailed columnar crystal. Moreover, since the residual stress inside a coat is also very large, an intergranular fracture is produced. Thus, oxygen invades along with the detailed crack which produced the coat with a detailed columnar crystal in the grain boundary. in cutting, the diffusion energy of the oxygen which has invaded since it is exposed to the elevated temperature of 850 degrees C - no less than 900 degrees C becomes still larger, and oxidation reaction with the

component in a coat promotes -- having -- just -- being alike -- oxidation will attain to even a cemented carbide base Moreover, a crack tends to spread such a coat in a coat by the shock with a workpiece, and it is easily kept very much in a deficit or exfoliation.

[0006] When this invention persons set to Ia (111) and Ib (220) diffraction intensity of a field and a field (220) which can set [1st] the X diffraction of a coat (111), respectively, in $1.0 < I_b(220)/I_a(111) \leq 5.0$, the diameter of crystal grain of a coat is large, and the value of $I_b(220)/I_a(111)$ found out the bird clapper. Moreover, it found out that the diameter of crystal grain of a coat is large, an intergranular fracture decreased and this phenomenon affected adhesion and oxidation resistance greatly by the bird clapper. It became the coat which carries out orientation to a field with many detailed intergranular fractures (111) strongly, and change was not regarded as it being $I_b/I_a \leq 1.0$ and $I_b/I_a > 5.0$ by the crystallized state, but even if it performed cutting, since an effect was not seen, having limited this numeric value limited adhesion etc. to the above-mentioned range.

[0007] When diffraction intensity of a field and a field (200) in the X diffraction (111) of a coat was set [2nd] to Ia (111) and Ic (200), respectively, reduction of the intergranular fracture of a coat was accepted in $2.0 \leq I_c/I_a \leq 40.0$, and the value of $I_c(200)/I_a(111)$ found out doing big influence like the above-mentioned. The coat from which it is set same by the above-mentioned to $I_c/I_a > 2.0$ and $I_c/I_a > 40.0$ to have limited to this numeric value is because change is not looked at by the crystal. Furthermore, the reason limited with $I_b/I_a < I_c/I_a$ about the X-ray intensity of a coat is explained. Since the intergranular fracture in a coat will increase, it will become a detailed columnar crystal and the target effect will no longer be acquired if it becomes $I_b/I_a > I_c/I_a$ when referred to as Ia (111), Ib (220), and Ic (200), it is the reason made into $I_b/I_a > I_c/I_a$.

[0008] This invention persons found out that oxidation resistance and adhesion with a cemented carbide base improved further by transposing a part of aluminum to one sort or two sorts or more of components among Zr, Hf, Y, and Si in the range below 10.0 atom % more than 0.03 atom % to aluminum in the nitride of Ti and aluminum, a charcoal nitride, and carbide the 3rd. It is for an intergranular fracture decreasing remarkably by addition of these components. For example, a thing [a thing] called it TiO₂ in the case of the coat which made conventional Ti and conventional aluminum the principal component when an addition component was set to X and the coat was exposed to the elevated temperature in the atmosphere and which add the addition component X although the porous oxide film has been formed very much. A precise oxide film called O(Ti, X)₂ was formed, and it found out that the amount in which external oxidation invades into a coat decreased remarkably. The reason which limited the addition of this addition component is explained. Even if the addition component X was which thing, when it was under 0.03 atom %, the effect of decreasing an intergranular fracture was not accepted to aluminum. Moreover, the oxide films TiO₂ and XO₂ formed during cutting also formed the very porous oxide film of a subject, and the target effect was not accepted for this invention persons. Moreover, when many addition components X were added from 30.0 atom % to aluminum, the residual compression stress of a coat became very large with -8.0--10.0GPa, and it checked that adhesion with a cemented carbide base deteriorated remarkably. Furthermore, in order that a bird clapper might be accepted in 1.5 or more times and coefficient of thermal expansion might reduce the elevated-temperature physical properties of a coat as compared with the coat of the nitride of Ti and aluminum which this invention persons invented, a charcoal nitride, and carbide, it limited to this range. Hereafter, based on an example, it explains in detail.

[0009]

[Example]

Using the example 1 arc ion plating system, as shown in Table 1, the compound nitride of Ti and aluminum, a charcoal nitride, and carbide were covered to the slow [made from SEE42 TN-G9 type cemented carbide] away insertion so that it might become 3-micrometer thickness. Moreover, comparison material was created using the equipment which created the invention for the comparison at this time. The distance which can be cut until exfoliation generates milling cutter cutting using the face cutter board using these samples in the slow [made from surface coating cemented carbide] away insertion which performed SKD61 (HRC45) material, 125mm width, and 250mm length to cutting-speed 100 m/min, 0.1mm of feed per tooth and an edge, a slitting depth of 2mm, and *-ed material by dry type by using, and created was written together to Table 1.

[0010]

[Table 1]

試料番号		皮膜	I(220)/ I(111)	I(200)/ I(111)	剥離発生までの 切削可能距離 (m)
本発明品	1	(Ti _{0.8} Al _{0.2})N	1.1	2.6	1.16
	2	(Ti _{0.8} Al _{0.2})N	2.9	13.0	1.34
	3	(Ti _{0.8} Al _{0.2})N	3.5	7.6	1.20
	4	(Ti _{0.4} Al _{0.6})N	4.1	31.0	1.16
	5	(Ti _{0.8} Al _{0.2})CN	3.0	15.0	0.89
	6	(Ti _{0.8} Al _{0.2})C	2.5	20.0	0.89
	7	(Ti _{0.8} Al _{0.2})N	4.9	39.5	0.98
比較品	8	(Ti _{0.8} Al _{0.2})N	0.8	0.6	0.36
	9	(Ti _{0.8} Al _{0.2})CN	11.0	1.8	0.31
	10	(Ti _{0.8} Al _{0.2})C	19.0	17.0	0.39
	11	(Ti _{0.8} Al _{0.2})N	0.5	42.1	0.23

[0011] Table 1 shows that the peeling resistance of this invention article improves remarkably by $1.0 < I_b/I_a \leq 5.0$ and $2.0 \leq I_c/I_a \leq 40.0$ at the time of $I_b/I_a < I_c/I_a$. This examination is for seeing wear whether advance normally or not, and however it may be hard and may cover the film which does not oxidize, if it will separate by resistance at the time of cutting, it is meaningless. Although this invention article is based on high degree-of-hardness material cutting, is consumed, and is attached and it has become 1.16m with the repeat shock 1 at the time, for example, a sample number, it eats, and it is attached and until expresses 11,600 times of ** which exfoliation of a coat does not produce.

[0012] Using the equipment used in the example 2 example 1, one sort or the coat of a component as added two or more sorts and shown in Table 2 was covered among Zr, Hf, Y, and Si, so that it might become the thickness of 3 micrometers to a predetermined test piece so that it might become composition of the range below 30.0 atom % more than 0.03 atom % to aluminum among the compound nitride of Ti and aluminum, a charcoal nitride, and carbide in a part of aluminum. Using the sample, among the atmosphere, it held at 800 degrees C for 1 hour, and the thickness of the formed oxidizing zone was measured. The result is also written together to Table 2.

[0013]

[Table 2]

試料番号		皮膜	I(220)/ I(111)	I(200)/ I(111)	酸化膜厚 (μm)	剥離発生までの 切削可能距離(n)
本 発 明 品	1 2	(Ti _{0.8} Al _{0.2})N	3.2	16.0	1.1	1.20
	1 3	(Ti _{0.8} Al _{0.2} Y _{0.2})N	4.1	36.9	0.5	1.51
	1 4	(Ti _{0.8} Al _{0.2} Si _{0.1})CN	1.5	40.0	0.66	1.40
	1 5	(Ti _{0.8} Al _{0.4} Zr _{0.8})C	1.1	2.6	0.59	1.49
	1 6	(Ti _{0.8} Al _{0.2} Hf _{0.2})N	2.3	11.7	0.81	1.63
	1 7	(Ti _{0.8} Al _{0.2} Y _{0.2})N	2.7	19.4	0.73	1.59
	1 8	(Ti _{0.8} Al _{0.4} Si _{0.2})N	4.6	9.8	0.9	1.50
	1 9	(Ti _{0.8} Al _{0.4} Zr _{0.4})N	3.1	20.2	0.55	1.48
	2 0	(Ti _{0.8} Al _{0.4} Y _{0.4})N	3.5	26.3	0.9	1.65
	2 1	(Ti _{0.8} Al _{0.4} Si _{0.2})N	2.0	2.1	1.0	1.55
比 較 品	2 2	(Ti _{0.8} Al _{0.2})N	0.7	1.2	2.1	0.29
	2 3	(Ti _{0.8} Al _{0.2} Y _{0.2})CN	3.1	29.3	1.9	0.37
	2 4	(Ti _{0.8} Al _{0.4} Ta _{0.2})N	2.6	10.5	2.8	0.31
	2 5	(Ti _{0.8} Al _{0.4} Si _{0.2})N	1.4	40.0	1.6	0.39
	2 6	(Ti _{0.8} Al _{0.2})C	3.8	2.6	2.6	0.28

[0014] Table 2 showed that advance of oxidization was stopped by oxidation resistance to the conventional coat, and the oxidization behavior which completely changes with differences in an X diffraction even if it is especially the film of the same component was shown in this invention article. Moreover, the sample which replaced a part of aluminum by the alloying element was able to stop oxidization more.

[0015] The coat used in the example 3 example 2 was covered so that it might become the thickness of 3 micrometers to a SEE42TN (G9) type slow away insertion, and the distance which can be cut until it performs a cutting examination in the cutting conditions shown in an example 1 and exfoliation of the created coat occurs was written together to Table 2. From Table 2, wear was able to advance in the normal state and this invention article was able to demonstrate the abrasion resistance of film original.

[0018]

[Effect of the Invention] Like the above, the tool which used the slow [made from surface coating cemented carbide] away insertion of this invention does not exfoliate in cutting of high degree-of-hardness steel materials, but it oxidizes and, for a ***** reason, the outstanding tool life is acquired.

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CLAIMS

[Claim(s)]

[Claim 1] The slow [made from surface coating cemented carbide] away insertion considering [when Ia (111) and diffraction intensity of a field (220) were set to Ib (220) / the value of Ib (220)/Ia (111)]-as range of $1.0 < Ib/Ia \leq 5.0$ characterized by the diffraction intensity of the field in the X diffraction (111) of the coat in the slow away insertion which covered the compound nitride of Ti and aluminum, a charcoal nitride, and carbide.

[Claim 2] The slow [made from surface coating cemented carbide] away insertion to which the value of Ic (200)/Ia (111) is characterized by making diffraction intensity of the field in the X diffraction (111) of the coat into $2.0 \leq Ic/Ia \leq 40.0$ and the range of $Ib/Ia < Ic/Ia$ in a slow [made from surface coating cemented carbide] away insertion according to claim 1 when Ia (111) and diffraction intensity of a field (200) are set to Ic (200).

[Claim 3] The slow [made from surface coating cemented carbide] away insertion characterized by transposing a part of aluminum to one sort or two sorts or more in Zr, Hf, Y, and Si in the range below 30.0 atom % more than 0.03 atom % to aluminum in a claim 1 or the slow [made from surface coating cemented carbide] away insertion of 2.

[Translation done.]